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METHODS OF SAVING METAL IN USSR MACHINE-TOOL BUILDING

One of the most important elements in the effective organization of machine-tool building is a decrease in the consumption of metal.

In working out measures to save metal, it must be remembered that the technical specifications of a lighter machine tool and its kinematic system must not be endangered.

Metal can be saved in machine-tool building by these four basic methods:

1. The weight of machine tools can be reduced by establishing a progressive type classification (tipazh) of machine tools and their technological and operating characteristics.

2. The weight of machine tools can be decreased by improving their design.

3. The coefficient of utilization of materials can be increased by reducing the weight of blanks and by using a more modern technology.

4. The weight and cost of materials can be decreased and greater machine-tool dependability can be assured by selecting less scarce materials.

A decrease in the weight of machine tools depends on the extent to which a group (ryad) of type sizes of machine tools and their technological and operating characteristics have been properly selected. From the standpoint of the manufacturer, it is better to have groups of machine tools with fewer type sizes in a group. However, from the standpoint of the consumer, it is better to have groups of machine tools with a greater quantity of type sizes in a group.

The economic expediency of a group of machine tools is determined by the amount and cost of materials. In modern machine-tool production, the cost of materials averages 40 percent of the manufacturing cost. The cost of metal is 3-3.5 times the amount spent for wages. Therefore, a group of machine tools in which a minimum amount of metal will be consumed will be economically more advantageous.

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A saving in metal also depends a great deal on the proper type classification of machine tools to be manufactured. Instead of a heavy type of machine tool which requires a large consumption of metal, a light type of machine tool which can machine without loss of accuracy should be selected.

Model 2631 horizontal boring machine (with a boring spindle 125 millimeters in diameter) weighs more than 30 tons and is an example of a poor machine-tool type. The selection of this type has led to considerable waste of metal. Model 2630 is now being manufactured instead of Model 2631. About 40 Model 2631 machine tools had been manufactured, at the cost of an excessive quantity of metal.

Model 1225 six-spindle automatic (with a maximum bar diameter of 25 millimeters) was also a poor selection. The weight of this machine tool is about the same as that of Model 1261, which machines parts up to twice the diameter.

In special cases, machine-building plants require machine tools of the same size but of heavy or light types. For example, Model 1556 double-sided vertical boring and turning mill is built for machining steel parts with a large allowance; the maximum work diameter is 2,500 millimeters and the machine tool weighs 42 tons. However, machine tools of the same size but 40-50 percent lighter are required. The need for heavy-type vertical boring and turning mills is relatively insignificant and, therefore, it is not necessary to manufacture them in large quantities.

The manufacture of universal machine tools is unprofitable at times. For example, the 6.8-ton Model 582 universal thread-grinding machines have been manufactured for several years, whereas it would be more expedient for large-series production to use simple, specialized machine tools which are more accurate, have changeable screws, and weigh considerably less.

A decrease in the weight of machine tools depends on improved designs. Parts should be designed to approximate the shape of inexpensive cast, stamped, die-forged, or fabricated blanks in order to reduce or eliminate the need for machining. In this way, 50-80 percent of the metal can be saved.

In designing shafts made from bar stock, the depth of recesses and flanges should be decreased and, wherever possible, spring rings, welded rings, pressed-on flanges, etc., should be used.

The weight of beds and other large machine-tool parts should be decreased by making their walls thinner. Walls from 10 to 25 millimeters thick are still being used. For example, the apron of Model 1A64 weighs 170 kilograms, is 825 millimeters long, 405 millimeters wide, and 460 millimeters high, and has 15-millimeter-thick walls. The frame of the tailstock of this model weighs 200 kilograms, is 930 x 518 x 395 millimeters in size, and has 25-millimeter-thick walls.

Nonferrous metal can be saved by making bushings and bearings from cast iron for light work, and from bimetals instead of bronze for heavy work.

The standardization of parts and units in various machine tools is of great importance in perfecting new types of machine tools, saving metal, and planning preventive maintenance. However, such standardization must be conducted on a technically sound basis.

Poor standardization of large parts for the Model 7A36 shaper (maximum ram travel of 700 millimeters) and Model 737 (ram travel of 900 millimeters) led to waste. The weight of both machine tools is about the same. Excessive metal is being used in the manufacture of the former, and the latter lacks sufficient rigidity.

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The weight of machine tools is determined basically by the large frame parts, which comprise about 60-70 percent of the total weight. It is not expedient to standardize heavy parts such as beds, headstocks, etc. among machine tools of similar size. It is more expedient to standardize shafts, gears, and other light parts.

In machine tools of different types, it is expedient to standardize separate units and body parts. For example, the production of standardized units has been mastered for Model 161 screw-cutting lathe, Model 161A lathe, Model 1336 turret lathe with horizontal head, Model 1338 turret lathe with vertical head, and a lathe operating with hard-alloy cutting tools. The following are common to all or most of these five machine tools: the bed, for four of these machine tools; gear box, for four of these; feed box, for all five; apron, for three; and the slide, for three. Such standardization makes it possible to broaden the series manufacture of separate parts and units and to use more progressive technology to reduce the consumption of metal considerably.

Stamped and fabricated and fabricated designs assure a considerable decrease in the weight of metal used in the manufacture of machine-tool parts. A 20-30 percent decrease in weight is achieved by converting from steel casting, while up to 45 percent is saved by converting from cast-iron casting.

For a long time, the Moscow Krasnyy Proletariy Plant, GZFS (Gor'kiy Milling Machine Plant), etc., have been using fabricated chip pans, housings, and other sheet-metal parts not carrying a load. A metal saving of up to 75 percent has been effected.

Since the weight of a cast-iron bed comprises 33-56 percent of the total weight of lathes and grinding machines, the possibility of converting it to a fabricated design should be studied. Fabricated beds made of thick sheet will not effect any great saving in metal. Therefore, sheet steel not more than 6 millimeters thick should be used.

In series production of small and medium machine-tool parts, fabricated blanks are less economical than cast parts.

In individual production of machine tools of any size, the use of fabricated designs is economically expedient since the parts require no expensive patterns and speed production.

In any scale of production of large, heavy machine tools, cast blanks are frequently less expedient than fabricated, in particular for parts and units which often have balancing loads.

An increase in the coefficient of metal utilization can be effected by processing methods which limit the waste of metal in producing finished parts.

At present, metal wasted in chips averages 28 percent of the total finished weight of castings. For example, the finished weight of the Model 1A62 bed is 680 kilograms whereas its cast weight is 870 kilograms. Metal wasted in forgings is from 40 to 50 percent.

Beds are cast at foundries of machine-tool plants with allowances on the ways of at least 15-20 millimeters; large frame parts such as headstocks and slides have allowances of up to 10 to 15 millimeters on the side. These allowances could be decreased to one half or one third.

Allowances on forgings of machine-tool spindles reach 20 millimeters on the diameter, whereas in press-formed blanks it is possible to have an allowance of only 5 millimeters on the side.

The weight of blanks in large-series production of 1,500 or more machine tools per year can be decreased by the following methods:

1. For medium and small castings, by molding with metal patterns on molding machines.

2. In mass production or for a higher quality of bed, by chill casting or, where possible, by centrifugal or die casting, with an allowance of up to 1-3 millimeters.

3. Castings for covers, brackets, etc., must have allowances on the surfaces not exceeding 2 millimeters so that they can be machined on roughing-grinding machines.

In order to save metal, forgings obtained by hot and cold press forming, cold upsetting, press forming with deep drawing (by the extruding process), and rolling should be handled as follows:

1. In producing 1,500 or more machine tools per year, press forming should be done in closed dies; in producing smaller quantities, in open dies.

2. Covers, housings, screws, levers, and pins can be obtained by cold stamping or upsetting, or by rolling without machining. Consumption of metal can be decreased 10-25 percent.

3. A large quantity of shafts, pins, keys, etc. can be produced from sized cold-drawn material without machining, or with one grinding; drawing bar stock up to 100 millimeters in diameter through a number of successive dies can yield blanks with cross-section sizes to the fourth class of accuracy and with adequate surface finish.

4. The manufacture of rings, bushings, etc. from thick-walled pipe stock can effect a metal saving of up to 60 percent. Bushings made from pressed powdered metal usually require no machining or only grinding.

Although these methods could be used to save metal, a number of machine-tool-building plants are still making gears from rolled stock. At the Odessa [Radial Drilling Machine?] Plant, gear blank No 2106 weighs 2,365 grams. Its finished weight is 710 grams. Thus, about 45 tons of alloy steel is wasted per year. [This would indicate that about 27,190 No 2106 gears are produced at the plant per year.]

A selection of less scarce materials can make it possible to decrease the weight of materials and assure a longer machine-tool life.

A part made of medium carbon steel with a surface hardened by high-frequency current is not inferior in quality to a part made of alloy steel with ordinary heat treatment. The use of alloy steels with an elongation up to 30 percent is not economical.

Gears made of carbon steel 45, hardened by high-frequency currents and shot peened, are not inferior to gears made from chrome-nickel steel 50KhN. In selecting a material, besides taking the load and conditions of wear into consideration, attention must also be given to the weight and cost of the part. Lightweight parts such as covers, small housings, high-speed pulleys, etc., are usually made of light alloys; however, cast iron is sometimes used when difficulties are encountered in obtaining aluminum alloys. It would be more expedient, particularly in large-series production, to make these parts out of plastic.

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Certain parts such as housings and covers are made from thin sheet steel, for example, in the manufacture of knee-type milling machines at the Gor'kiy Milling Machine Plant.

Counterweights can be made of concrete or can consist of welded boxes filled with sand. If the area is inaccessible, it is possible to suspend the counterweight by a block and pulley which will cut the load in half. For example, the Odessa plant did this with one type of machine tool and saved 750 kilograms of cast iron per machine tool. [[redacted] for related report in which the Odessa plant is identified as the Odessa Radial Drilling Machine Plant.] The Kolomna Heavy Machine Tool Plant has also replaced cast-iron counterweights with concrete ones in the vertical boring and turning mills it produces.

Nonmetallic materials such as plastic, glass, concrete, and ceramic materials are not being given sufficient attention in machine-tool building, while in other branches of industry coil springs, gears, worm gears, ball and roller bearings, etc., are being made from special ceramic materials with a high content of titanium and magnesium, pressed almost dry under a pressure of up to 150 atmospheres.

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